SES Sample Work Assignments

"INNOVA Mission Lifecycle Support"

1 OVERVIEW

The INNOVA mission is a fictitious earth science satellite mission defined to allow the offeror an opportunity to illustrate a wide range of experience, skills, and efficient management and development processes. Additionally, bidders can demonstrate an understanding of the complexities of working the many aspects of a mission's lifecycle in the NASA/GSFC/SES environment. The work described spans many of the mission support activities routinely provided by the Software Engineering Division for a typical mission.

2 MISSION DESCRIPTION AND ASSUMPTIONS

INNOVA is the first of a new series of low-cost, rapid development missions to study the earth's environment as a precursor to the establishment of a long-term space-based climate monitoring capability. Each of these low-cost missions will test the feasibility of certain new instrument sets. The total lifecycle effort from the start of Phase B to the end of operations is 58 months and is fully contained within the period of performance of the SES contract. It is assumed that the traditional Phase A effort has already been completed by NASA civil servants.

2.1 Mission Characteristics

The earth science INNOVA mission has been assigned to GSFC for overall management, development and operations. The total budget is compatible with costs associated with past missions of the space science Small Explorer (SMEX) Program.

The spacecraft will be placed in a 400 km circular orbit at a 52 degree inclination to maximize observations over the middle-latitudes.

Data: Overall data requirements are considered on the medium/low end for typical GSFC missions:

- 12 kbits/second real-time housekeeping telemetry

- 512 kbits/second file downlink rate
- 1.2 Gbits science data recorded for daily downlink
- 0.5 Gbits engineering data recorded for daily downlink
- CCSDS protocols and formats for real-time telemetry and command
- CCSDS CFDP file transfers for all recorded data downlink and for command load uplink
- All space-ground communications will be via TDRSS
- 4 Kbps command uplink, 1000 commands per day (95% contained in stored time-tagged command loads, 5% real-time uplink to the spacecraft primarily to coordinate the contact)

Satellite Bus: GSFC is responsible for the in-house development of the satellite bus and the integration with all of the instruments.. Multiple GPS receivers on-board are planned for position, time, and frequency reference.

Instruments: The spacecraft has four instruments. Two are nadir-pointing, and the other two point to the horizons (front and back) along the direction of travel. Each instrument requires daily command loads to configure filters and power levels.

Instrument A and B – This pair of instruments are each nadir pointing, non-steerable volume survey instruments with a 20 degree wide field of view. Each collects high-resolution atmospheric chemical and dust analysis data to be used in very long-term trending climate change research. This is the first use of these instruments.

Instrument C and D – These two instruments produce much less data than A and B and look at the atmospheric edge (horizon) to collect calibration data for use in the analysis of the A and B data. The field of view is ten degrees, but it is aligned in the vertical instead of horizontal orientation. Although originally intended for only periodic calibration activities, the Phase A study team has suggested some possible scientific value of continual data collection.

Operations Concept: The high-level operations concept was developed during Phase A, although several study areas were defined and additional concepts for further efficiencies are to be considered. The operational schedule can be done on a weekly basis, with a single time-tagged command load being uplinked once per week. Mid-week updates are expected a couple times per year based on needs identified through real-time telemetry monitoring. The government wants to consider the risks of lights-out operations for weekends and for one shift per day. Operations will be performed under the MOMS-II contract in building 32 at GSFC's Greenbelt, MD campus. There is an expectation that INNOVA will be one of GSFC's most efficiently operated earth science missions.

Ground System Deployment: The design and integration of the mission operations center will be handled through the MOMS-II contract, and not by SES. SES provides representation for COTS and GOTS products to be considered for use in the MOC system and will provide updates, maintenance, training and technical support for the 580-owned software products.

Science Data Processing System (SDPS):   The SDPS will be developed and operated at GSFC. The SDPS includes data file accountability, data archiving, data reformatting, higher level data processing, and data distribution functions.

2.2 Mission Milestones

The mission shall conform to the standard GSFC Project Lifecycle as shown in the diagram below, with key dates shown in the table that follows.
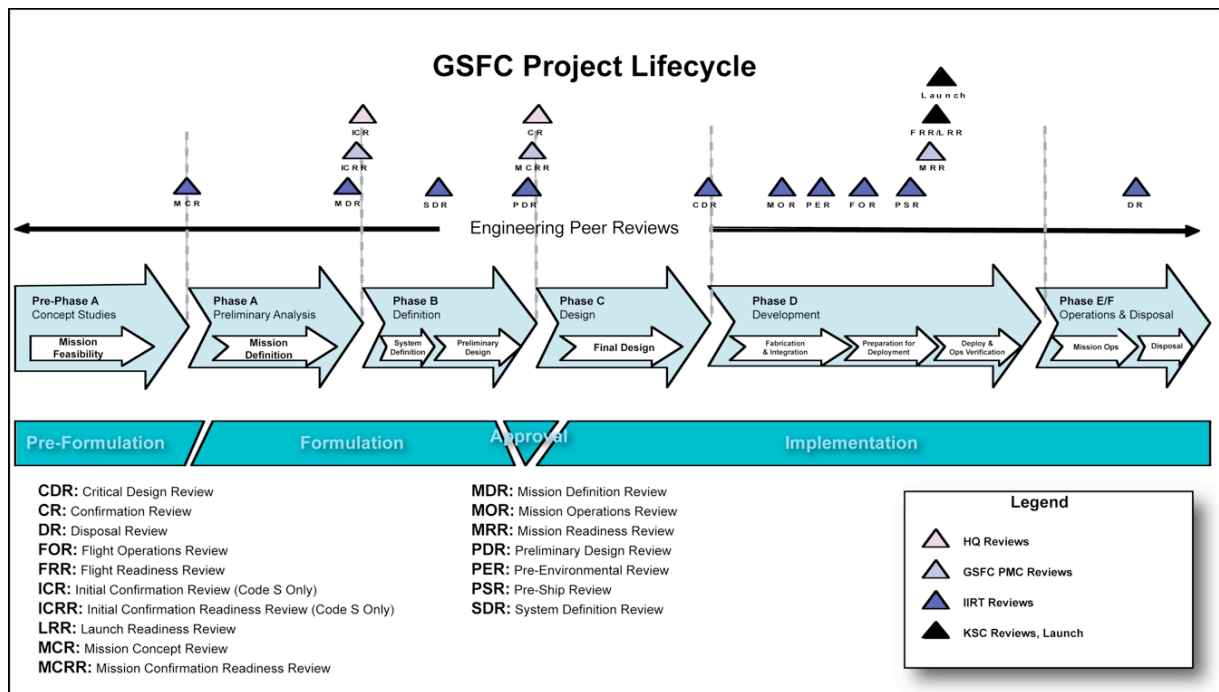
PHASE	END-DATE	FINAL MILESTONE
Phase A	April 1, 2010	SRR
Phase B - Definition	December 1, 2010	PDR
Phase C - Design	August 1, 2011	CDR
Launch	October 1, 2013	--
Phase D – Development	December 1, 2013	Launch + 60 days
Operations	January 31, 2015	--

2.3 Applicable Documents and Standards

The INNOVA mission has been declared to be a NPR 7150.2 Class B mission requiring CMMI Level 2 compliance. Detailed compliance standards are contained in the documents listed in the Applicable Documents section of the SES RFP.

3 TECHNICAL ASSIGNMENT DESCRIPTIONS

SES Work assignments will be aligned with the GSFC Code 580 Branch organization and be traceable to the SES Statement of Work. Support for a full mission, therefore, requires multiple individual work elements and different tier levels. The following table summarizes the work that will be coordinated by each functional organization:

Software Systems Engineering, Studies and Analysis (WBS 1.1)

Work Title: INNOVA Phase B
WBS Element: 1.1
Lead Organization: Code 581
Budgeted Hours: 6,500 hours
Start Date: April 1, 2010
End Date: December 1, 2010

Work Title: INNOVA Phase C
WBS Element: 1.1
Lead Organization: Code 581
Budgeted Hours: 1,500 hours
Start Date: December 1, 2010
End Date: August 1, 2011

The contractor shall be responsible for leading the key efforts of the INNOVA Phase B activities under the direction of the NASA INNOVA Ground Systems Manager.

The agreement has been made with the MOMS-II contract management team that the INNOVA Phase B will be conducted under the SES contract with limited (average of 1.5 engineers) of support from the MOMS-II operations team.

Several contractors from the flight and ground software systems organizations will support this effort (included in the budget number above).

The contractor shall perform trade studies:
1. Combining the operation of this mission with another GSFC operations
2. Single shift vs. multiple shift for nominal operations
3. Selection of TT&C system among ASIST, ITOS, and commercial options
4. Selection of planning and scheduling system

The contractor shall update the operations concept document and develop the ground system level 3 requirements document based on these trades and changes elsewhere in the INNOVA project.

The contractor shall develop the following documents:
1. Level 3/4 requirements for the MOC, including TT&C, planning and scheduling, and trend analysis components.
2. Interface control document between the MOC and the Science Operations Center
3. MOC preliminary design documentation
4. MOC Test Plan
5. MOC IT Security Plan

The contractor shall present the preliminary MOC design at the INNOVA Preliminary Design Review.

Milestones and Deliverable:

Trade study report: August 1, 2010
Updated Ops concept: September 1, 2010
Updated level 3 requirements and Level 4 Requirements: September 1, 2010
MOC/SOC ICD; October 1, 2010
MOC Test Plan: November 1, 2010
MOC I&T Security Plan: November 1, 2010
INNOVA PDR: December 15, 2010

In Phase C, the key activities for system design shifts to the appropriate design and development organizations. The Software Systems Engineering, Studies and Analysis organization shall maintain a coordination role to support system-wide analysis efforts and to ensure process and product consistancy across all of the ongoing SES INNOVA work areas.

Flight Software Systems (WBS 1.2)

Work Title: INNOVA Flight Software Systems Phase C and D
WBS Element: 1.2
Lead Organization: Code 582

Budgeted Hours: 50,000 hours
Start Date: December 1, 2010
End Date: December 1, 2013

Work Title: INNOVA Flight Software Sustaining Engineering (FSSE)
WBS Element: 1.2
Lead Organization: Code 582
Budgeted Hours: 8,000 hours
Start Date: May 1, 2013
End Date: January 31, 2015

The contractor shall support the government in the design, development, integration, test, and delivery of the INNOVA FSW. The INNOVA FSW includes the Command and Data Handling (C&DH) and Attitude Control System (ACS) functions. The contractor shall support FSW build and system development, FSW product integration, FSW system validation testing, and FSW verification and validation. The contractor shall also work with the INNOVA Flight Software Sustaining Engineering (FSSE) team to ensure meeting FSSE maintenance requirements. One-third of the development effort will be performed by civil servants and 2/3 by the contractor team.

The contractor shall perform trade studies:
- Assessing whether the INNOVA FSW should be built upon the FSW Branch's Common Flight Executive (cFE).
- Selection of FSW Re-use from the FSW Branch's Core Flight Software (cFS) and other mission FSW, including GPM.
- Selection of real-time operating system from VxWorks, VRTX, or by developing a specialized INNOVA-specific OS.

The Contractor shall provide FSW Development and Build test services in support of the INNOVA C&DH and ACS FSW. This shall include;
- Code and Build test for INNOVA C&DH FSW Build 1.0
- Code and Build test INNOVA C&DH FSW Build 2.0
- Code and Build test of INNOVA C&DH FSW Build 3.0
- Code and Build test of INNOVA ACS FSW Build 1.0
- Code and Build test of INNOVA ACS FSW Build 2.0
- Code and Build test of INNOVA ACS FSW Build 3.0
- Code and Build and System Test reports

The Contractor shall provide INNOVA FSW System Test services in support of the INNOVA FSW verification and validation (V&V) effort. This shall include:
- Development of test scenarios, procedures, and test tools required to perform FSW system testing validation and verification
- Guidance Navigation and Control (GN&C) system test scenario and procedure development
- C&DH system test scenario and procedure development

- Development of operational scenarios and stress test scenarios in support of ACS and C&DH system testing
- Development of INNOVA FSW System Test Plan and final report
- Provide problem reports documenting cases where FSW functional and/or performance requirements are not satisfied

The Contractor shall also support the INNOVA FSW V&V Lead in the following areas:
- S/C Acceptance Test Execution Runs
- S/C Comprehensive Performance Testing
- S/C Mission Simulation testing

The contractor shall also support the government in determining an action plan for the following risk factor: Because the GN&C flight hardware designs and procurements are immature relative to the INNOVA FSW need dates, two potential issues have been identified:
1. The GN&C FSW development schedule could slip and with a corresponding reduction in adequate GN&C FSW testing time prior to spacecraft I&T.
2. The simulator development could slip impacting the simulator's ability to be used to verify the functionality contained in a FSW build and/or slipping the GN&C FSW build verification test schedule.

The contractor shall support the development of the following:

Deliverables
INNOVA S/C FSW
Final C&DH Software Image
Final ACS Software Image
Associated Products
Updated INNOVA S/C FSW Level 3 Requirements Document
Updated C&DH FSW Requirements Documents
Updated ACS FSW Requirements Documents
WA-3 Status Meeting and Report
INNOVA S/C FSW Configuration Management Plan
INNOVA S/C FSW Software Preliminary Design Review (PDR) presentation package

INNOVA S/C FSW Software Critical Design Review (CDR) presentation package
INNOVA S/C FSW C&DH User's Guide
INNOVA S/C FSW GN&C User's Guide
INNOVA S/C FSW Command Definitions Document
INNOVA S/C FSW Telemetry Definitions Document
INNOVA S/C FSW Test Plan
INNOVA S/C FSW Build Verification Test Procedures Document
INNOVA S/C FSW System Test Readiness Review (STRR) package*
INNOVA S/C FSW System Validation Test Procedures Document
INNOVA S/C FSW Acceptance Test Results Review (ATRR) package
Support for Mission Simulations and S/C Comprehensive Performance Testing

Phase E Flight Software Sustaining Engineering Support (FSSE) shall start several months before launch. The contractor shall provide pre-launch INNOVA FSSE preparations and on-orbit FSSE support. The contractor shall also support the INNOVA FSW Development team in specifying FSSE maintenance requirements, and will also support FSW build, system, and acceptance testing.

Pre-launch the contractor will develop an appropriate INNOVA FSW Mission Operations tools set, support pre-launch mission simulations, develop FSSE documentation (as per table below), establish post-launch FSW patch methodologies, support the relocation of the INNOVA FSW Testbed to long term on-site facilities, and develop regression tests for post-launch FSSE support.

Post-launch the contractor shall support launch and in-orbit checkout, support the analysis and recovery from on-orbit anomalies, provide consultation to the INNOVA Flight Operations Team (FOT), design, develop, test, and support uplink of FSW patches, ensure the proper functioning of the INNOVA FSW Testbed, and provide a current archive of all FSW versions, associated tools, testbed software & databases.

All FSSE support will be documented by Configuration Change Requests (CCRs), which will capture all changes to configured items, including the FSW, and Work Requests, which will capture all other work. The contractor shall participate in the INNOVA FSW Configuration Control Board (CCB).

The contractor shall support the development of the following:

Deliverables
INNOVA FSW CM Plan
INNOVA FSSE Plan
INNOVA Operations Interface Agreement
INNOVA Regression Test Set
INNOVA FSW Testbed Move and Recertification
INNOVA CCB Meetings
FSW Patches
INNOVA FSW Archive

Ground Software and Systems (WBS 1.3)

Work Title: INNOVA Ground Systems Phase C and D
WBS Element: 1.3
Lead Organization: Code 583
Budgeted Hours: 3,500 hours
Start Date: April 1, 2010
End Date: December 1, 2010

In Phase C, the contractor shall support the government in the preliminary design of the INNOVA ground system.

The contractor shall develop, integrate and test the planning and scheduling/command load generation system for the INNOVA MOC. This system is responsible for accepting the science plan for the operations of the four instruments, scheduling the TDRSS contacts, and generating the validated command loads containing instrument and spacecraft commands. The contractor shall support the integration of this system with other MOC systems.

Milestones and Deliverable:
- Initial Release – Launch minus 12 months
- Launch ready release: launch minus 6 months7/1/2012

Description of Work: Maintain the planning and scheduling system/command load generation system for the INNOVA mission. Resolve discrepancy reports and implement any new requirements approved by the INNOVA CCB. Provide expedited deliveries as during the spacecraft checkout and commissioning phase in early calendar year 2013.

Milestones and Deliverable:

New releases in November 2012, February 2013, June 2013, and December 2013

Flight System Verification and Validation (WBS 1.4)

Work Title: INNOVA Phase B
WBS Element: 1.4
Lead Organization: Code 584
Budgeted Hours: 3,500 hours
Start Date: April 1, 2012
End Date: October 1, 2013

Lead the Mission Readiness Team for the INNOVA mission. Develop the test plan to verify the level 3 ground system requirements. Coordinate the interface and end-to-end tests. Document the test results and coordinate any retests that are required. Submit test issues to the INNOVA discrepancy tracking system.

The Mission Readiness Test team will be led by an SES contractor and will include contractors from the MOMS II contract and participants from all of the ground system components.

Supporting Services (WBS 1.5)

Work Title: INNOVA Phase B
WBS Element: 1.5
Lead Organization: Code 585
Budgeted Hours: 3,500 hours
Start Date: September 1, 2011
End Date: January 31, 2015

Provide systems administration for the INNOVA flight software development and test systems, including:

> configuration management
> desktop support
> firewall configuration
> network configuration
> backups
> new product installation
> platform maintenance

Work Title: INNOVA Phase B
WBS Element: 1.5
Lead Organization: Code 585
Budgeted Hours: 1,200 hours
Start Date: December 1, 2010
End Date: October 1, 2013

Provide Software Process improvement support to the INNOVA flight software and ground systems teams. Train the teams, and provide support in establishing the software processes required. Mentor the team throughout the development process.

Science System Development (WBS 1.6)

Work Title: INNOVA Science Data Processing System Phase C and D
WBS Element: 1.1
Lead Organization: Code 586
Budgeted Hours: 18,500 hours
Start Date: December 1, 2010
End Date: July 1, 2013

The INNOVA Science Data Processing System (SDPS) will be located at GSFC. The SDPS is responsible for science data accountability, processing, archiving, and sharing the Science Data for the INNOVA mission. All of the raw science data will be received from the Mission Operations Center as files. There is no real-time science data downlink.

Description of Work: The contractor shall support the government in the design, development, integration, test, and delivery of the Science Data Processing System (SDPS).   The SDPS includes data capture, data archiving,   data reformatting, higher-level data processing, and data distribution functions.   The contractor shall perform a trade study that assesses which existing system will be reused for the INNOVA SDPS. The contractor shall define the level 3 requirements, the SDPS design, and the test plan. The contractor shall provide a document that the science team can use to provide their algorithms and software that is required to produce the higher-level products.

4 ACRONYM LIST

ACS	Attitude Control System
ASIST	Advanced System Integration and System Test
ATRR	Acceptance Test Results Review
CCB	Configuration Control Board
CCR	Configuration Change Request
CCSDS	Consultative Committee for Space Data Systems
CDR	Critical Design Review
CFDP	CSDS File Delivery Protocol
cFE	Core Flight Executive
cFS	Core Flight Software
CMMI	Capability Maturity Model Integration
C&DH	Command and Data Handling
COTS	Commercial Of The Shelf
FOT	Flight Operations Team
FSSE	Flight Software Sustaining Engineering
FSW	Flight Software
GN&C	Guidance Navigation and Control
GOTS	Government Of The Shelf
GPM	Global Precipitation Mission
GPS	Global Positioning Satellite
IT	Information Technology
ITOS	Integrated Testing and Operations System
MOC	Mission Operations Center
PDR	Preliminary Design Review
SES	Software Engineering Support
SDPS	Science Data Processing System
SMEX	Small Explorer
SRR	Systems Readiness Review
STRR	System Test Readiness Review
V&V	Verification and Validation
WBS	Work Breakdown Structure
TT&C	Tracking, Telemetry, & Command